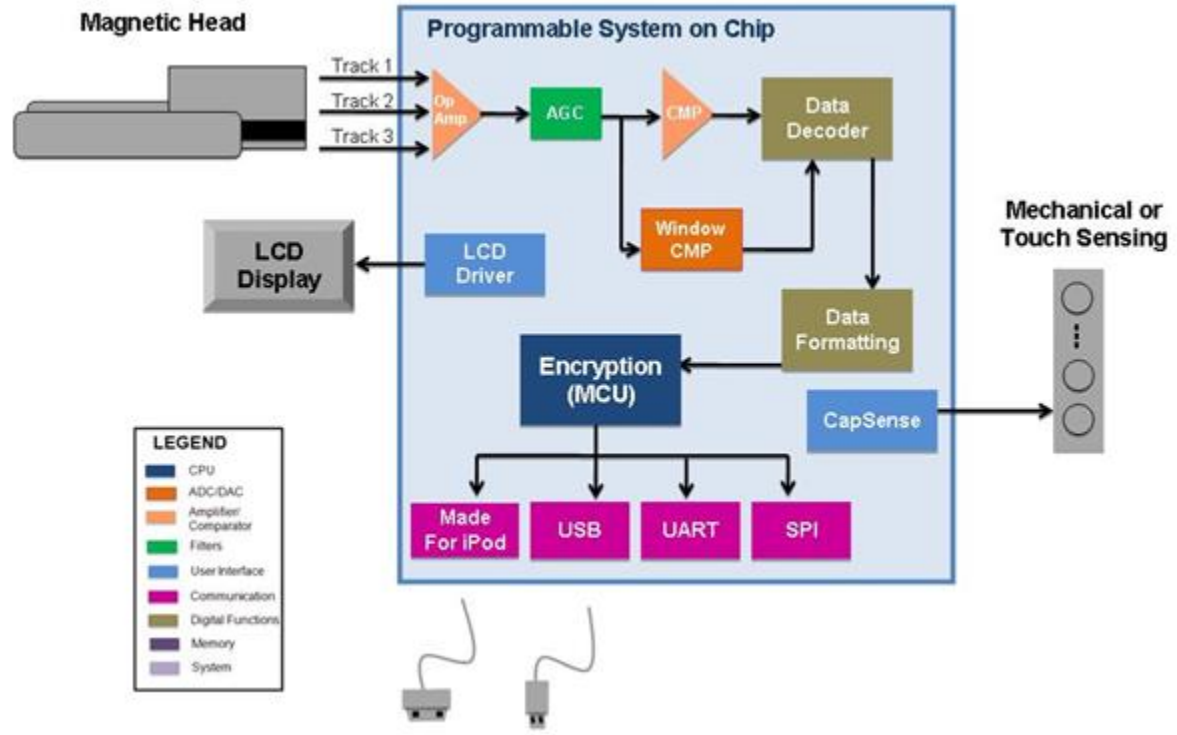
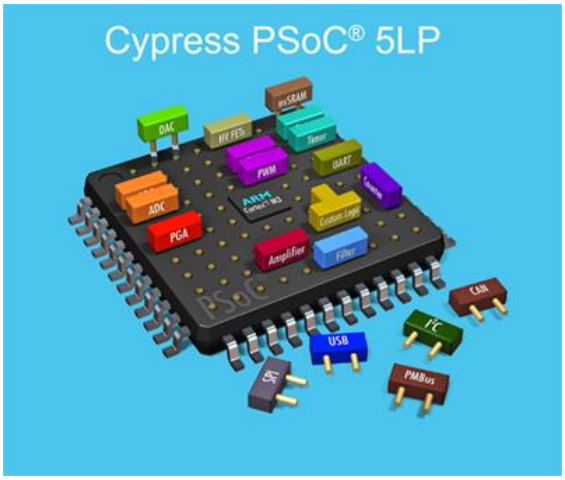
PSoC 5LP (Cypress Semiconductor) Magnetic Card Reader Project





By Troy Pandhumsoporn
July 28, 2016
Independent Non-Academic Study Project/Design Challenge

Main Objective:

Slide a magnetic card through the reader in which data is transmitted serially through the RS-232 (UART) port on the PSoC 5LP development kit to the computer. Open up a terminal/client such as Putty, HyperTerminal, or TeraTerm program, etc. and view pure ACSII/serial data streams on the computer. Try to see if the information of a swipe can be saved to a MicroSD card/OpenLog for analysis.

Other Objectives:

- Understand the layout on how the serial information is laid out.
- Find/develop de-encryption software that could decode or make sense of magnetic card data to view what information is actually imprinted on a magnetic card.
- If the data is already decoded, then sift through the data finding relevant patterns or borders that identify categories of groupings.

Introduction:

The Magnetic Card Reader has been a ubiquitous form of information exchange in thousands of everyday applications that range from retail credit card terminals to ATMs to access control systems (mobile processing terminals for applications in taxis, limos, swap meets, delivery services, home businesses). While RFIC has been the latest enhancement to be added with the magnetic strip, a lot of legacy systems still use the plain old magnetic strip readers/writers because the costs to replace them (new software, modules, and low priority security (library cards, shopper cards, pre-paid phone cards) for low-security applications.

A magnetic stripe card is a type of PVC card with a band of magnetic material embedded into resin on the back of the card. Electronics engineers can now leverage the flexible Magnetic Card Reader architecture and pre-developed magnetic card sub-system to cut development time and reduce the bill-of-materials cost with the integration of the analog front end and associated A/Ds while leaving plenty of processing power and other PSoC resources for further system integration.

The flexibility and power of the PSoC architecture can allow embedded designers to include a three-channel Magnetic Card Reader into their applications for virtually no cost, while the new reference design provides this subsystem in a complete and tested form to simplify the development process.

Source Code:

Code is adapted from a Silicon Laboratories 8051 MCU core application note. Pin configurations connections are also adapted from the PSoC magnetic card reader application notes. (Not really too hard to find online).

Possible Encryption:

Triple DES or AES (Asynchronous Encryption Standard) using C libraries, optionally one could use Verilog/VHDL for hardware description language to implement a more secure encryption scheme (over using software).

Magnetic Card Reader C library

http://www.instructables.com/id/Turn-your-Arduino-into-a-Magnetic-Card-Reader/step9/Code-Download-and-Wrapup/

http://www.instructables.com/id/Arduino-magnetic-stripe-decoder/

http://stripesnoop.sourceforge.net/

http://www.element14.com/community/docs/DOC-48037/l/cypress-an54374--application-note-on-magnetic-card-reader-for-psoc-3-family

http://www.instructables.com/files/orig/F8F/O3U9/FJBYZ4T9/F8FO3U9FJBYZ4T9.txt

http://www.element14.com/community/docs/DOC-62279/l/cypress-an54374--software-code-for-magnetic-card-reader-using-psoc-creator-beta5

The PSoC 5LP Implementation of a Three Track Magnetic Card Reader with Automatic Control Gain Feature
http://ftp1.digi.com/support/documentation/0220082_b.pdf

As we know that the smart Magnetic Card Reader has a guide and a connector that engages contacts on the card. When the machine senses that the card is in place and the related code has been keyed in, the memory device embedded in the card can be read. Some types can also modify the data on the card, e.g. debiting the amount of credit available. There is no doubt that it is so useful and necessary for our life.

The usual reason that some people won't buy that kind of technology is that it is bulky, expensive and they don't have a permanent place of business where they can install that in. Magnetic Card Reader on magneticcardreaderwriters are commonly used, you can see it at so many place. After more than 40 years of relying on the same basic Credit Card Reader technology, the humble plastic credit card is about to get smart. From cards with buttons and displays on the front to those that can be programmed to keep you on a budget, a number of new innovations are in the works. Europe moved to smarter, chip-enabled cards years ago, but the size of the magnetic stripe infrastructure in the U.S. has made that type of widespread change difficult, since millions of new card readers would be required. So in a new twist,

some companies are now creating interactive cards that work with ordinary Magnetic Card Reader and the Magnetic Card Reader Writer.

A magnetic stripe card reader for reading a magnetic stripe on a card having at least one track of magnetically stored information stored thereon as a stream of encoded discrete data bits separated by bit times is disclosed. Aa magnetic head is provided for reading the magnetic pulses as the magnetic stripe is passed thereby to output a time varying analog signal. A data converter incorporated on an integrated circuit is then operable for converting the analog signal to a digital time series of digital values. A processor incorporated on the integrated circuit can ten process the digital output of the data converter and is operable to first determine potential bit boundaries and then recover timing information from the digital time series to discriminate the bit times between data bits. The value of each data bit is then determined during each bit time to provide a stream of extracted data bits.

Abstract

Using the

Subject	Specification		
Track standard	Comply with ISO7811		
Decoding method	F2F (FM)		
Starting character	Track 1"%"	Track 2"? "	Track 3"+"
Card reading Data bit	Track 1 79 Characters (7-bit)	Track 2 40 Characters(5-bit)	Track 3 107 characters(5-bit)
Card thickness	0.2~0.84 mm		
Suitable Voltage	DC5V±0.5V		
Static current	10mA/5V		
Track reading width	1.5mm		
Magstripe passing speed	15 - 120 cm/sec (6-50inch/sec)		
Magnetic head life span	More than 800,000 passes		
Error rate	Lower than 0.5%		
Interface	RS232,USB,PS/2		

Figure _: Technical Data and Specifications – The highlighted rectangles give the most significant information in determining the GUI hardware configurations for the PSoC.

VI RS232 Communication Interface

Data type	Format
Baud rate	9600bps
Data bit	8 bit
Check bit	None
Stop bit	1 bit

Figure _: UART specifications to plug into the PSoC.

DB9 Pinout

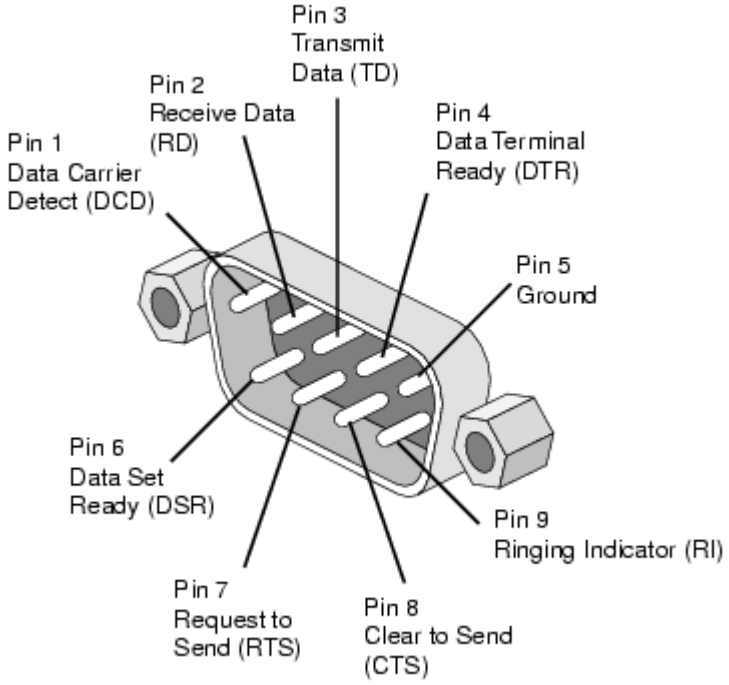


Figure _: DB9 Connector (RS-232) Serial Port on the PSoC 5LP board and the magnetic card reader requires an M/M adapter or respective wires, and physically represents the UART interface for the system.

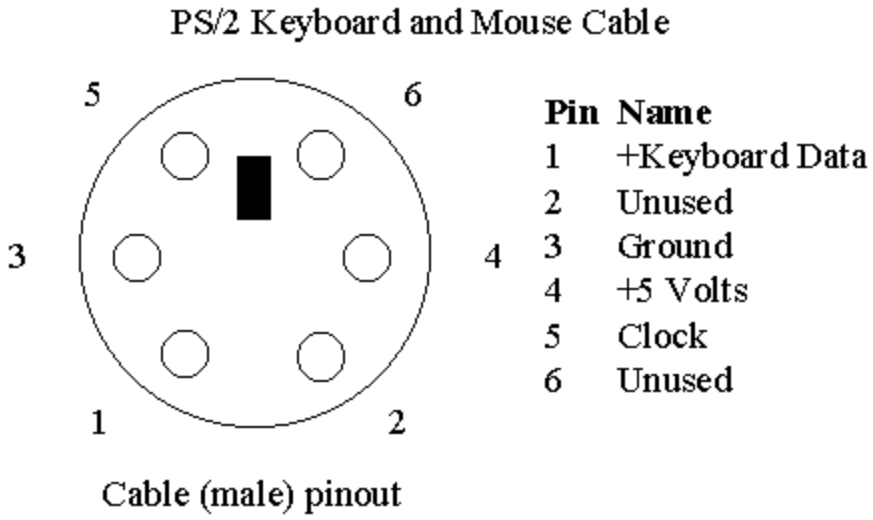


Figure _: To power the magnetic card reader, Pin 3 and Pin 4 are the only pins needed to connect respectively to GND and Vdd, on the PSoC board. Pin 1 could be used if a keyboard was needed for user input, but is not needed.

The PSoC 5LP has a wide array of power options: The 12V DC-DC power adapter could be used to power the development using a wall socket with a medium sized cord. A 9 V battery can be used for portable alkaline battery application on the go.

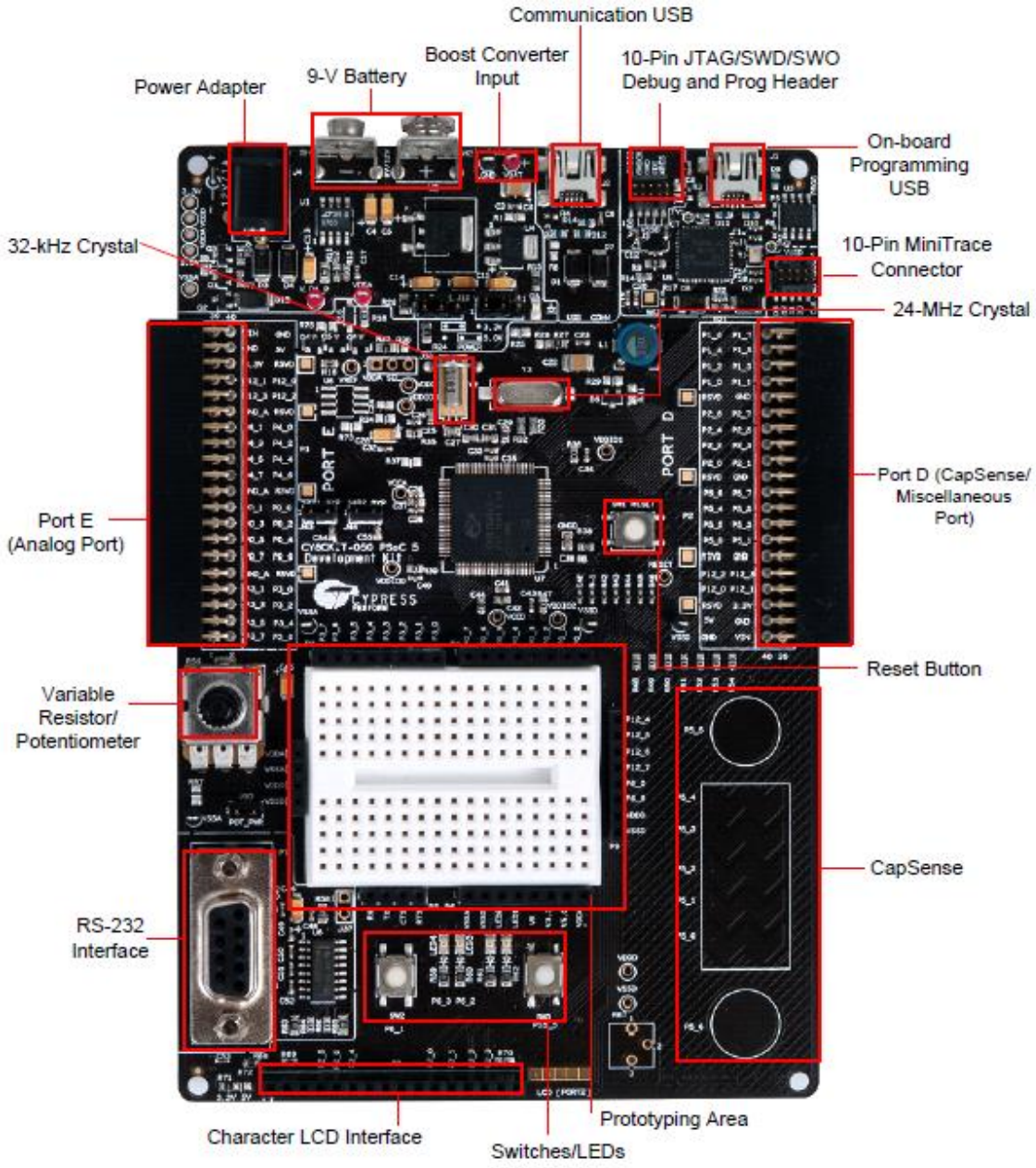
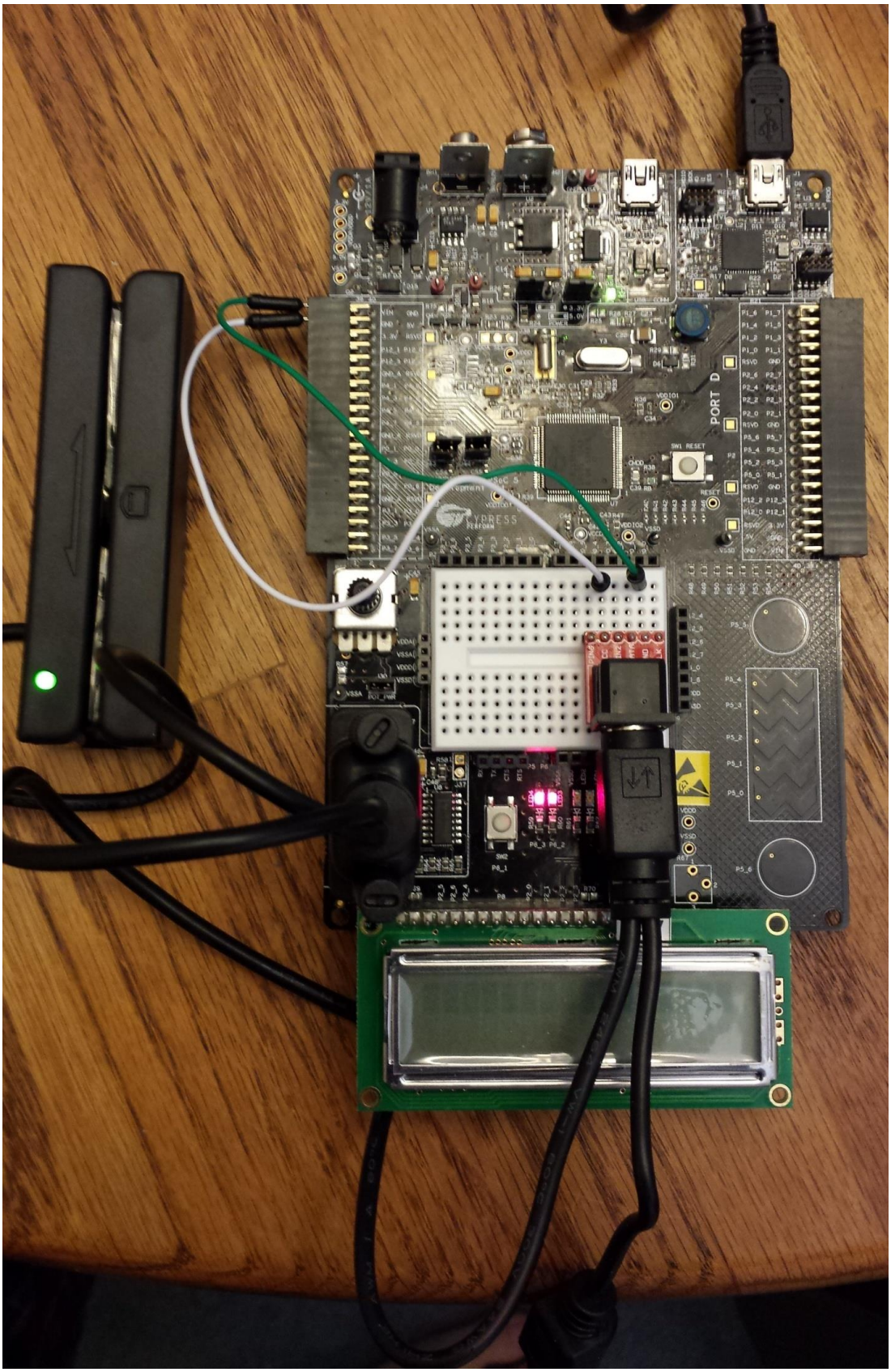
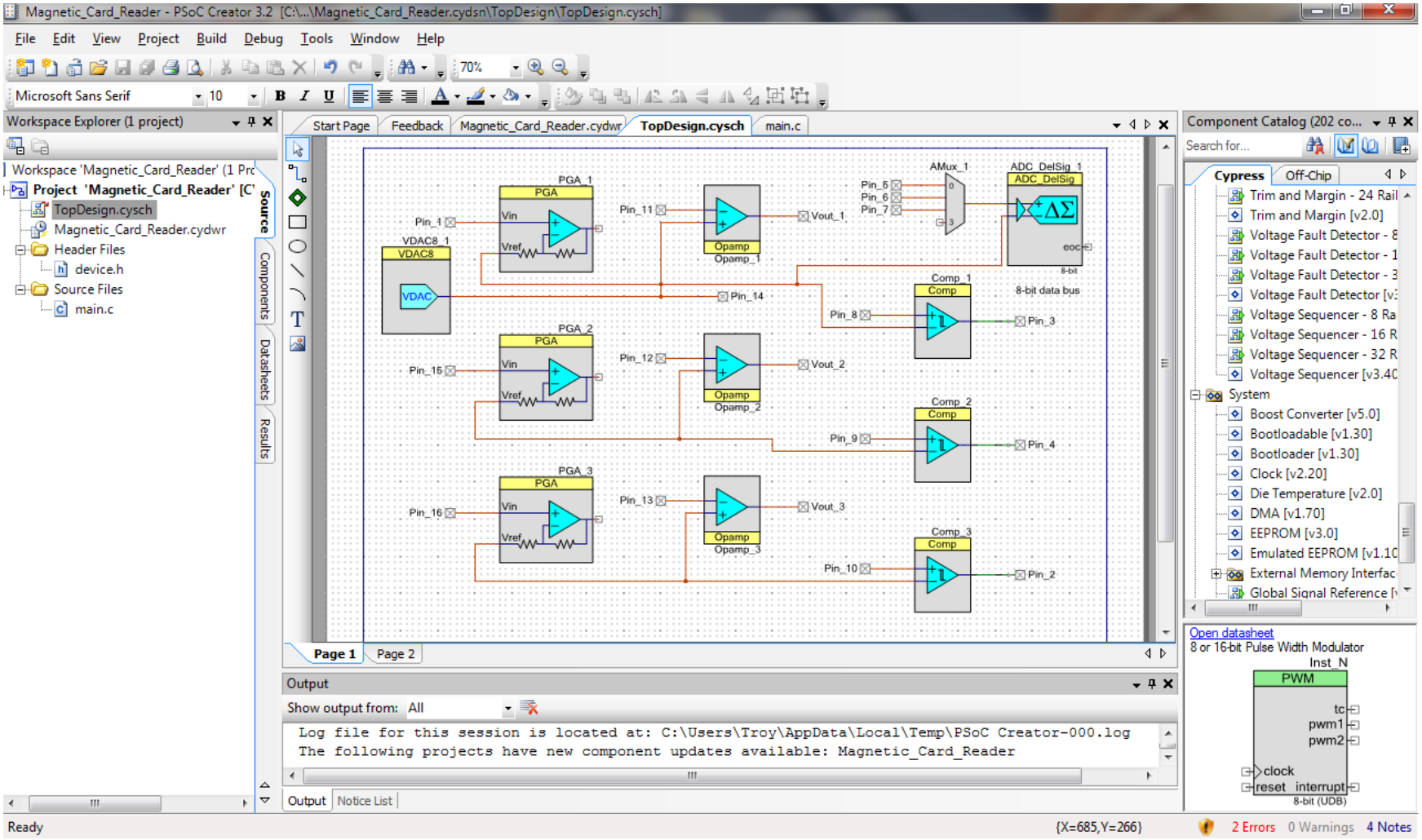


Figure _: PSoC 5LP development Kit Layout


PORT D
SW1 RESET
RESET


Magnetic_Card_Reader - PSoC Creator 3.2 [C:\...\Magnetic_Card_Reader.cydsn\TopDesign\TopDesign.cysch]
File Edit View Project Build Debug Tools Window Help
Workspace Explorer (1 project)
Workspace 'Magnetic_Card_Reader' (1 Pro
Project 'Magnetic_Card_Reader' [C'
TopDesign.cysch
Magnetic_Card_Reader.cydwr
Header Files
device.h
Source Files
main.c
Source
Components
Datasheets
Results
Start Page
Feedback
Magnetic_Card_Reader.cydwr
TopDesign.cysch
main.c
PGA_1
PGA_2
PGA_3
VDAC8_1
VDAC8
Opamp_1
Opamp_2
Opamp_3
AMux_1
ADC_DelSig_1
Comp_1
Comp_2
Comp_3
8-bit data bus
Page 1
Page 2
Output
Show output from: All
Log file for this session is located at: C:\Users\Troy\AppData\Local\Temp\PSoC Creator-000.log
The following projects have new component updates available: Magnetic_Card_Reader
Output
Notice List
Component Catalog (202 co...
Search for...
Cypress
Off-Chip
System
Open datasheet
8 or 16-bit Pulse Width Modulator
Inst_N
PWM
tc
pwm1
pwm2
clock
reset
interrupt
8-bit (UDB)
Ready
{X=685,Y=266}
2 Errors
0 Warnings
4 Notes

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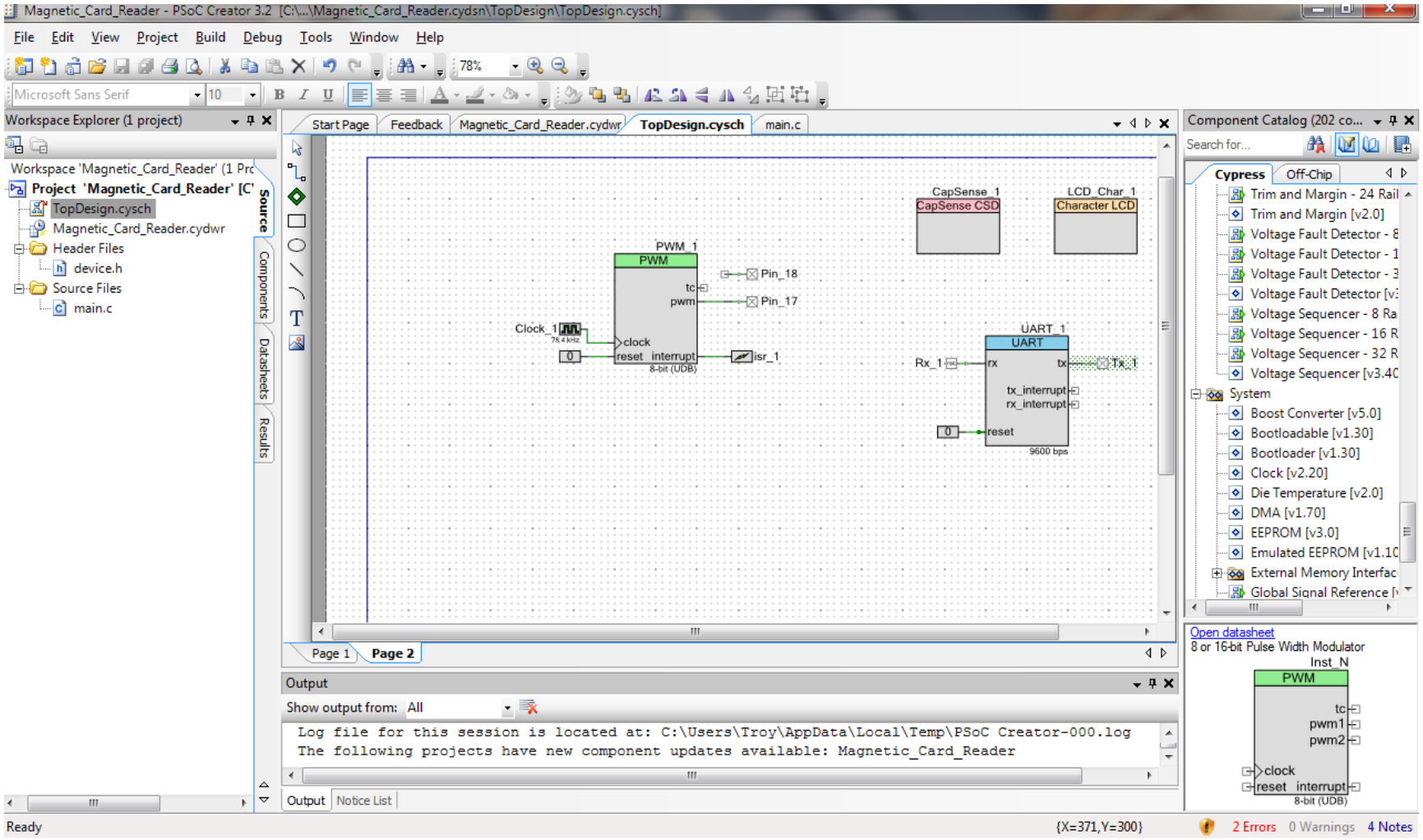
Magnetic_Card_Reader - PSoC Creator 3.2 [C:\...\Magnetic_Card_Reader.cydsn\TopDesign\TopDesign.cysch]
File Edit View Project Build Debug Tools Window Help
Workspace Explorer (1 project)
Workspace 'Magnetic_Card_Reader' (1 Prc
Project 'Magnetic_Card_Reader' [C'
TopDesign.cysch
Magnetic_Card_Reader.cydwr
Header Files
device.h
Source Files
main.c
Source
Components
Datasheets
Results
Start Page
Feedback
Magnetic_Card_Reader.cydwr
TopDesign.cysch
main.c
CapSense_1
CapSense CSD
LCD_Char_1
Character LCD
PWM_1
PWM
tc
pwm
Pin_18
Pin_17
Clock_1
clock
reset_interrupt
8-bit (UDB)
isr_1
UART_1
UART
Rx_1
rx
tx
Tx_1
tx_interrupt
rx_interrupt
reset
9600 bps
Page 1
Page 2
Output
Show output from: All
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Output
Notice List
Component Catalog (202 co...
Search for...
Cypress
Off-Chip
Trim and Margin - 24 Rail
Trim and Margin [v2.0]
Voltage Fault Detector - 8
Voltage Fault Detector - 1
Voltage Fault Detector - 3
Voltage Fault Detector [v3
Voltage Sequencer - 8 Ra
Voltage Sequencer - 16 R
Voltage Sequencer - 32 R
Voltage Sequencer [v3.40
System
Boost Converter [v5.0]
Bootloadable [v1.30]
Bootloader [v1.30]
Clock [v2.20]
Die Temperature [v2.0]
DMA [v1.70]
EEPROM [v3.0]
Emulated EEPROM [v1.10
External Memory Interfac
Global Signal Reference [v
Open datasheet
8 or 16-bit Pulse Width Modulator
Inst_N
PWM
tc
pwm1
pwm2
clock
reset_interrupt
8-bit (UDB)
Ready
{X=371,Y=300}
2 Errors
0 Warnings
4 Notes

Image	Name	Description	Distributor	Qty.	Subtotal
	**U1**	PSoC 5LP Development Kit (could also go for the cheaper PSoC 5LP Prototyping Kit for $10.00)	Mouser, Digi-key, PSoC Cypress Store	**1**	From University, but retails for $99.00
	**MAG1**	Magnetic Card Reader (RS232, PS/2, DB9)	SparkFun	**1**	$45.00
	**BAT1**	Mini Gender Changer M/M	Fry's Electronics	**1**	$3.99 (now $4.99)
		MiniDIN 6-Pin Connector	SparkFun	**1**	$0.95 (no longer sold)
		MiniDIN 6-Pin Connector Breakout	SparkFun	**1**	$0.95 (no longer sold)
Miscellaneous Parts: resistors, electrolytic, ceramic capacitors,			Parts Bin		
			Total		

Improvements:

- Interested coworkers/partners/collaborators with a better understanding of embedded systems programming (oriented with how security systems work) and computer systems/software engineering could help realize it as a product.

- The character LCD interface could use a larger LCD instead of the stock 3.3V 16x2 LCD provided in the kit (at least the 20x4 to provide more serial information on the display or even a graphical LCD module could work). The SMT resistor will have to be re-soldered onto the 5V if possibly for those models. Because of the author's inability to solder small SMT parts (burned through a whole stock of one type of SMT), the task is left to someone else more skilled to take this project from evaluation to production.

- CY3280-MBR3 Cap Sense® MBR3 Evaluation Kit: The Cap Sense provided in the PSoC 5LP can be expanded upon by buying this evaluation kit; however, an off-the-shelf capacitive/mechanical keypad can be added for better user interface as opposed to a card swipe and a few buttons/sliders from the kit itself.

- Add a solenoid lock to evolve the system into architecting a magnetic door access system. Requires an additional/separate power supply for 12V and switch current.

BOBibliography

Theory behind the Magnetic Card Reader
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http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=21&ved=0CDwQFjAAOBQ&url=http%3A%2F%2Fwww.cec-mc.ru%2Fdata%2Ffiles%2FFile%2FPDF%2FPSOC.ppt&ei=8vPBUpHsHMnxoATbwoGIBQ&usg=AFQjCNF14jEZ5JwIxKQ5dJvPW4tXHYXu4A
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Arduino Sample Code

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http://www.cypress.com/?rID=46526&source=header

http://www.cypress.com/?rID=45518

http://www.repairfaq.org/filipg/LINK/F_Phrack_Mag.html

Google: magnetic stripe card reader source code

http://www.digitalcheck.com/pos-encryption-overview/

Google: F2F encoding